The Reaction $^{10}B(p, \alpha)\ ^{7}Be$

Philip R. Page, T-16

The reaction of ^{10}B with a proton to form an α-particle and unstable ^{7}Be is evaluated. The fact that the recoil nucleus (here ^{7}Be) is in its ground state will be indicated by a subscript "0" from now on. The current analysis is the first evaluation ever performed for this reaction, except for an evaluation of the S-factor for $^{10}B(p, \alpha_0)$ [1], which is important in astrophysics.

An R-matrix fit of experimental nuclear data on the elastic scattering reaction $^{10}B(p, p_0)\ ^{10}B$ and of the exothermic reaction $^{10}B(p, \alpha_0)$ is performed. The data range from 0.02–3 MeV, yielding an evaluation up to 3 MeV. Data sets from ten experimental references with 1845 data points are used.

The angular distribution of the cross-section is given by the structure of the resonances and backgrounds, which is determined by the elastic scattering data of Chiari 2001 from 0.5–3 MeV, and by the known resonance at the threshold of the reaction. These data fit remarkably well, after the statistical and systematic errors are inflated. The overall x^2 per degree of freedom for all data entered is 2.2.

The evaluated $^{10}B(p, \alpha_0)$ cross-section is presented in Fig. 1. The reaction clearly shows several resonance peaks above 0.8 MeV. The large renormalizations needed for the modern Angulo 1993 and Youn 1991 data may not be a concern as it is known that these reactions disagree by large factors. It is comforting that the Chiari 2001 data, which is available above 0.5 MeV, determine the normalizations of the Angulo 1993 and Youn 1991 data, while itself fitting with normalizations within 4% of the experimental value. The normalization of the low-energy $^{10}B(p, \alpha_0)$ data is hence strongly constrained by the $^{10}B(p, p_0)\ ^{10}B$ data. The same is true about the other $^{10}B(p, \alpha_0)$ data. The exact normalizations of this data above 1.5 MeV have changed considerably at various stages of the analysis.

The differential cross-section for $^{10}B(p, \alpha_0)$ is shown in Fig. 2. A well-known resonance is clearly visible.

An evaluated cross-section file in evaluated nuclear data file (ENDF) format is prepared for the reactions $^{10}B(p, \alpha_0)$ and $p^{10}B$ elastic scattering in the energy range 0.01–3 MeV. Maxwellian averaged cross-sections in nuclear data interface (NDI) format are prepared for the reaction $^{10}B(p, \alpha_0)$. These may not be very accurate below a temperature of about 10 keV.

Details of the analysis are available in Ref. [2].

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[1] C. Angulo, et al., *Nucl. Phys. A* **656**, 3 (1999).
[2] P.R. Page, "^{11}C Nuclear Data Evaluation," Los Alamos National Laboratory report LA-UR-05-6250 (August 2005).

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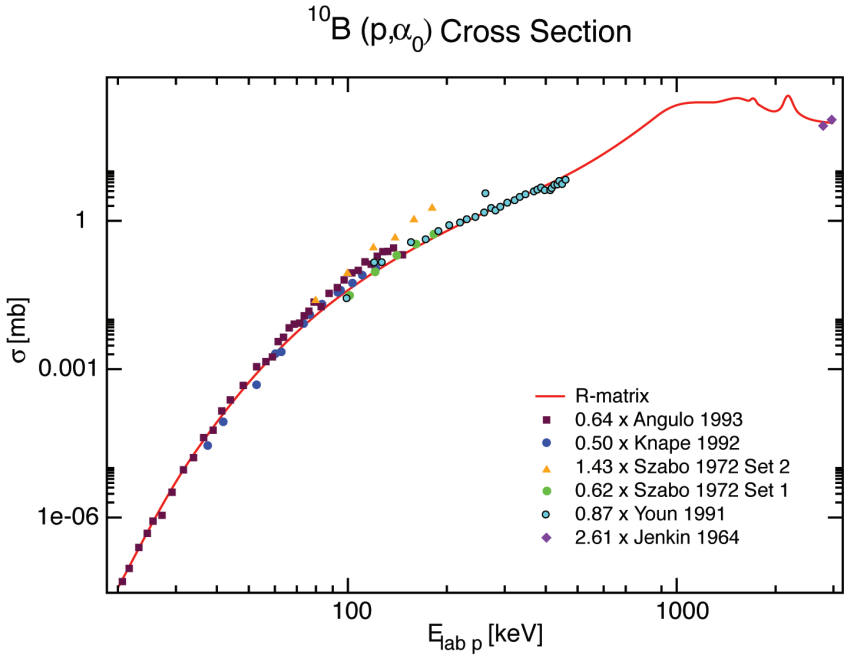

Fig. 1.
The R-matrix analysis cross-section (red curve) in millibarns for the ^{10}B(p, α_0) ^{7}Be reaction up to a proton laboratory energy $E_{lab\ p}$ of 3 MeV, with the six sets of experimental (integrated) cross-section data entered in the analysis. The numerical factors in front of the experimental data labels indicate that the data must be multiplied by those factors to obtain the points plotted.

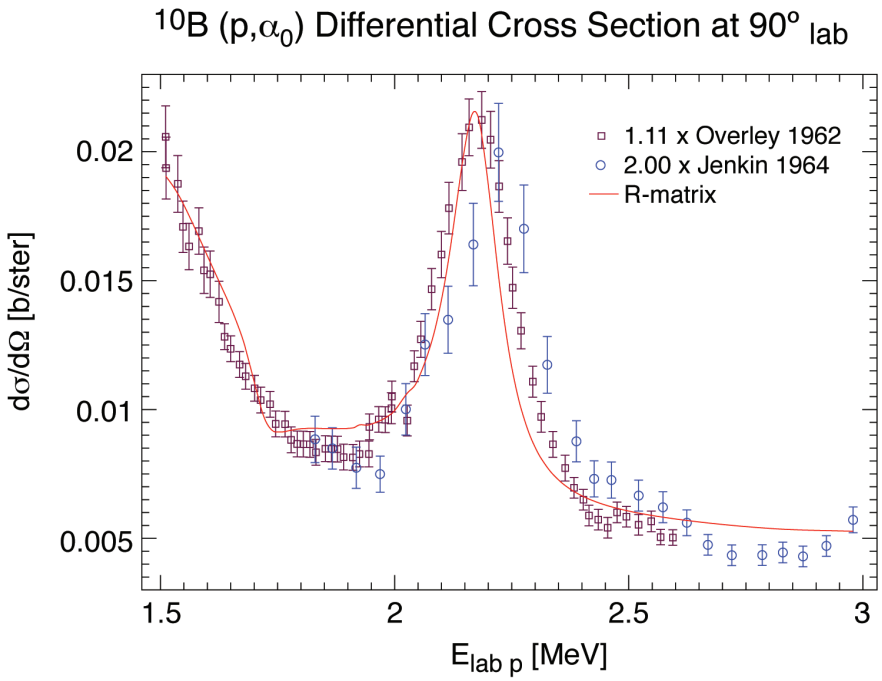

Fig. 2.
Same as in Fig. 1, except that this is for the differential cross-section at 90° laboratory angle, and two sets of data are shown.